APPENDIX 2
ACCESS ROAD CULVERT DESIGN

By FCG Date 7-WEHRAN ENGINEERING Job No. 2534
Chkd. by Dat Engineers & Scientists Sheet No. 1 of 13
Subject HALLADAY CULVERT SIZING

METHOD: RATIONAL $Q = CIA$

SOURCES: ① "TIME OF CONCENTRATION OF SMALL DRAINAGE BASINS" p 362 Kirpich, Civil Engineering, Vol 10, No 6, June 1940

② "RAINFALL INTENSITY CHARTS" BINGHAMPTON, NY

③ HYDRAULIC CHARTS FOR THE SELECTION OF HIGHWAY CULVERTS Bureau of Public Roads, Hydraulic Engineering Circular No 5, 1965.

④ DESIGN CHARTS FOR OPEN CHANNEL FLOW, Federal Highway Administration, Hydraulic Design Series No 3, 1973.

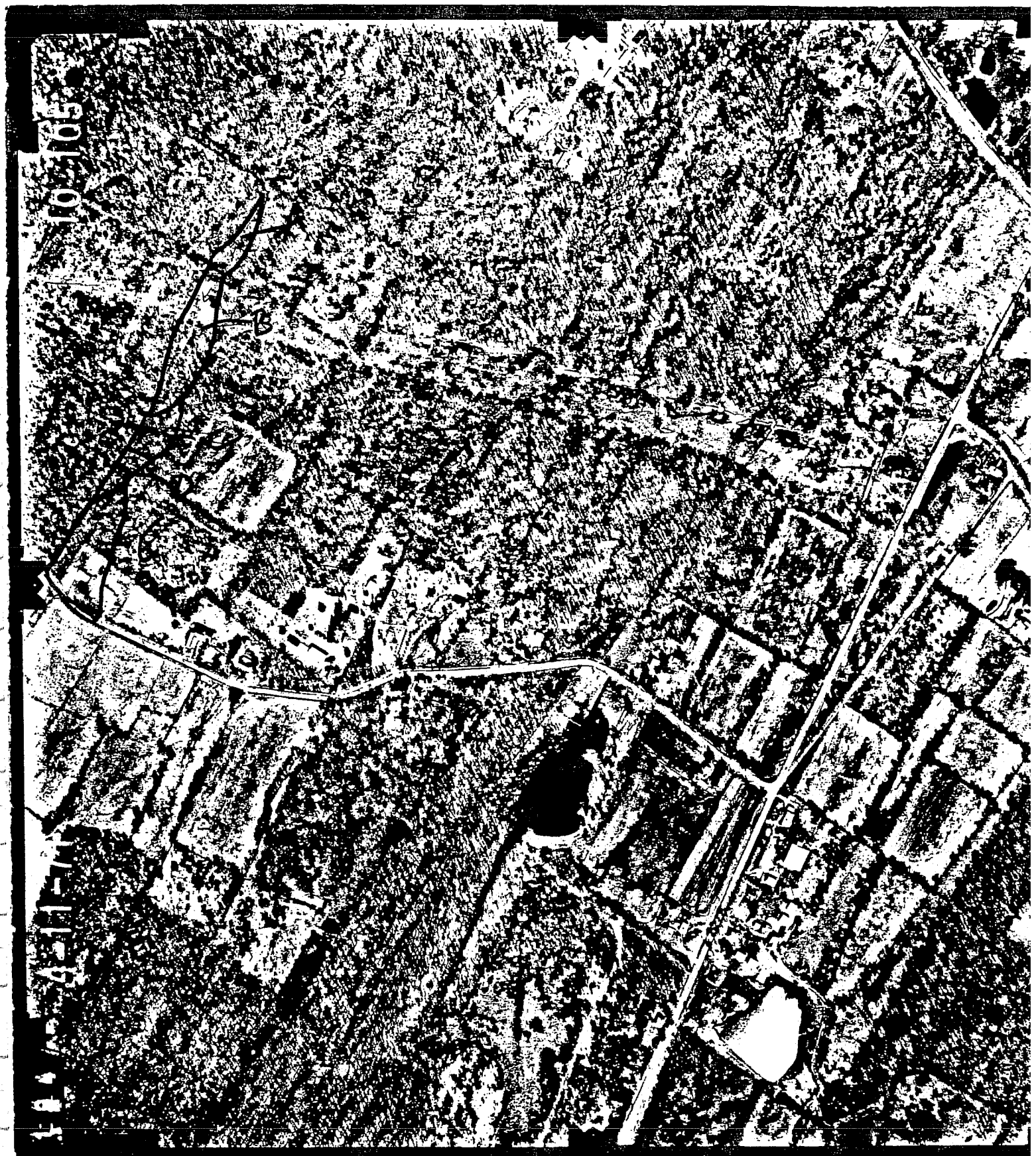
⑤ ARCHITECTURAL STANDARDS

Assumed C values:

WOODED	0.15
RESIDENTIAL	0.35
BRUSH	0.35
PAVEMENT	0.95

STORM FREQUENCY : 25 YR

1A/13



By _____ Date _____ WEHRAN ENGINEERING Job No. 5754
Chkd. by VW Date 8-88 Engineers & Scientists Sheet No. 2 of 13
Subject AREA CALCULATIONS

$1 IN^2 = 250{,}000$ SF

AREA	READINGS IN^2		SF	ACRE
A	.082 .082	.082	20,500	.47
B	.287 .302 .272	.287	71,750	1.65
C	.157 .152 .152	.152	38,000	.87
D	.055 .057	.056	14,000	.32
E	.362 .355 .360	.359	89,750	2.06

By HG Date 6-7-88 WEHRAN ENGINEERING Job No. 5534
Chkd. by ____ Dat ____ Engineers & Scientists Sheet No. 3 of 13
Subject CULVERT

AREA A

A = .47 Ac dense Brush

C = .35

I: H = 700 - 680 = 20 L = 300' $T_c = 2 \times 2 = 4$ min (1.8, 3.6)

I = 7.0

Q = (.35)(7.0)(.47) = 1.15 cfs ✓

12" CMP. 30' @ 1.0% AREA A USE 12" MITER CMP

AREA B

A = 1.65 ✓

$C = \frac{(.33)(.35) + (.67)(.15)}{1} = 0.22$

I: H = 680 - 635 = 45 L = 550' $T_c = 3.6 \times 2 = 7.2$ min

I = 6.3

Q = (.22)(6.3)(1.65) = 2.3 cfs ✓

31'-15" CMP @ 1.0% AREA B USE 15" CMP MITERED

AREA C

A = .32

C = .15

I: H = 640 - 625 = 35 L = 280 $T_c = 1.5 \times 2 = 3$ min

I = 7.0

Q = (.15)(.32)(7.0) = .34 cfs ✓ from Area A use 12" CMP MITERED

PROJECT: 07534 DESIGNER: FCG

DATE: 6-2-88

HYDROLOGIC AND CHANNEL INFORMATION

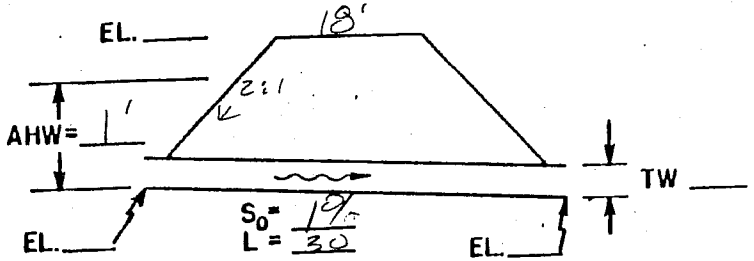
Q_1 = 1.15 TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: A &1/6+60



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION: INLET CONT. HW/D	INLET CONT. HW	OUTLET CONTROL HW=H+h_o-LS_o: K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW	CONTROLLING H.W.	OUTLET VELOCITY	COST	COMMENTS
MITERED	1.15	12"	.64	.64	.7	NA					.3			25		

SUMMARY & RECOMMENDATIONS:

Figure 7

Case 7:07-cv-10711-KMK Document 1-11 Filed 11/30/2007 Page 6 of 25

PROJECT: 07534

DESIGNER: FCG

DATE: 6-2-88

HYDROLOGIC AND CHANNEL INFORMATION

Q_1 = 2.3

Q_2 = _____

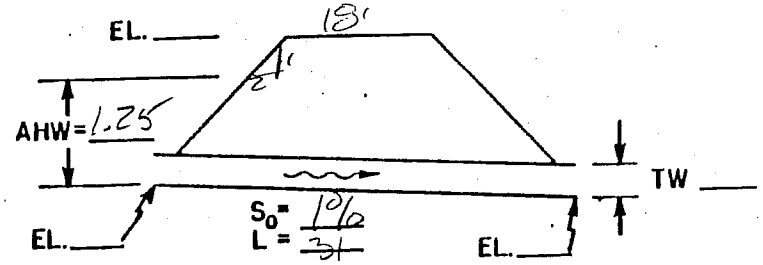
TW_1 = _____

TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: B 29+80



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROLLING HW	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL HW=H+h_o-LS_o											
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
MITERED	2.3	15	.71	1.89	NA									3		

SUMMARY & RECOMMENDATIONS:

Figure 7

Case 7:07-cv-10711-KMK Document 1-11 Filed 11/30/2007 Page 7 of 25

By ____ Date ____ WEHRAN ENGINEERING Engineers & Scientists Job No. 01554
Chkd. by ____ Date ____ Sheet No. 6 of 13
Subject CULVERT SIZING

AREA D (combined E+D - grade road ditch)

A- 2.06 + .32 = 2.38

C: .25(.35) + .70(0.15) + .05(95) = .24

I: H= 635 - 597 = 38 L = 750 T_c = 5'

I= 7.0

Q = (.24)(7.0)(2.38) = 4 cfs ✓

PROJECT: 07534

DESIGNER: FG

DATE: 6-2-88

HYDROLOGIC AND CHANNEL INFORMATION

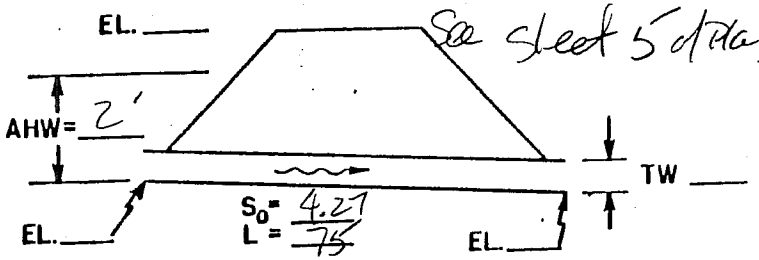
Q_1 = 4 TW_1 = _____

Q_2 = _____ TW_2 = _____

(Q_1 = DESIGN DISCHARGE, SAY Q_{25}
Q_2 = CHECK DISCHARGE, SAY Q_{50} OR Q_{100})

SKETCH

STATION: D 0+30



MEAN STREAM VELOCITY = _____

MAX. STREAM VELOCITY = _____

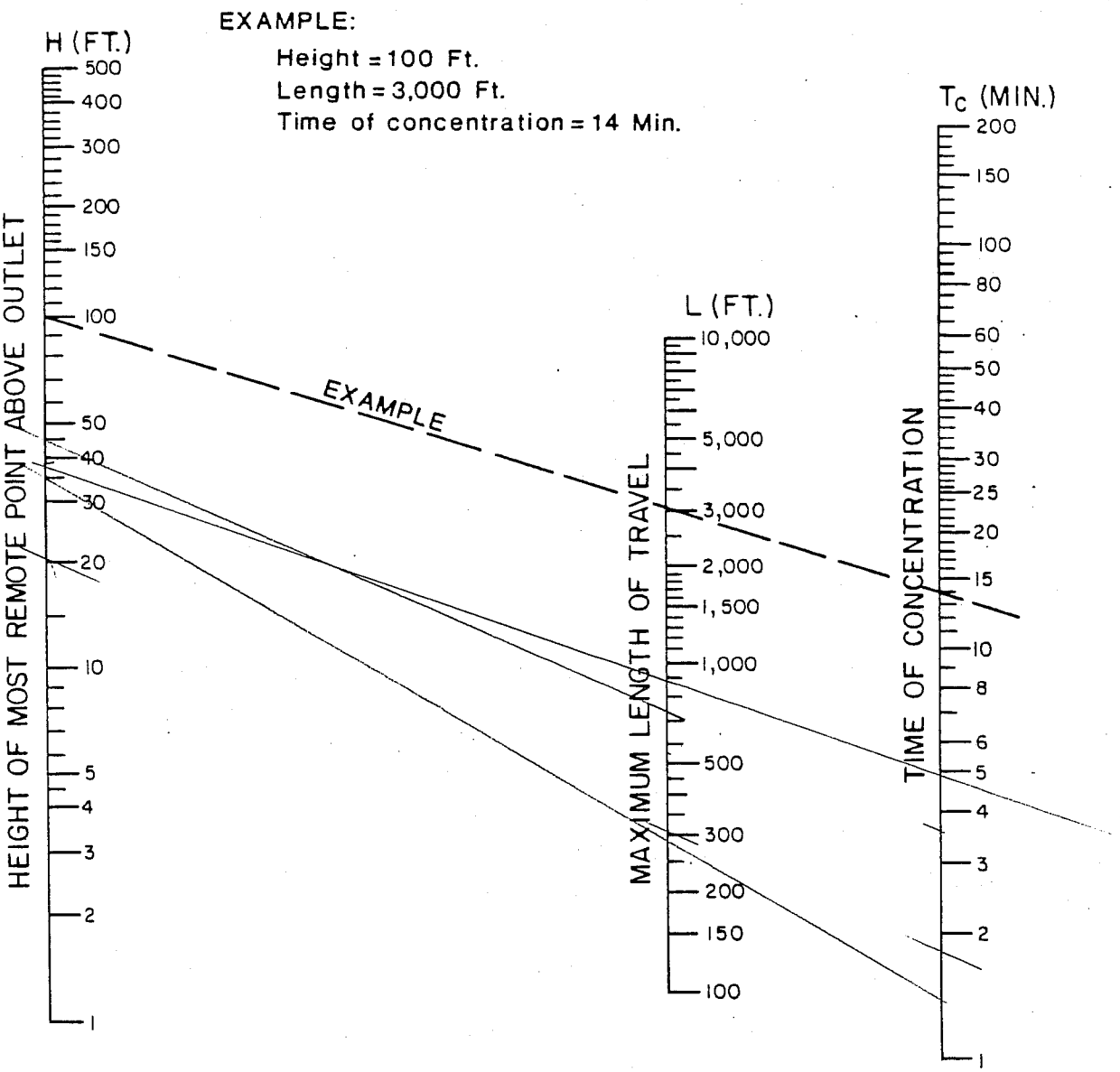
CULVERT DESCRIPTION (ENTRANCE TYPE)	Q	SIZE	HEADWATER COMPUTATION										CONTROLLING H.W.	OUTLET VELOCITY	COST	COMMENTS
			INLET CONT.		OUTLET CONTROL HW=H+h_o-LS_o											
			$\frac{HW}{D}$	HW	K_e	H	d_c	$\frac{d_c+D}{2}$	TW	h_o	LS_o	HW				
MITER	4	18	.74	1.11	NA									5.9		

SUMMARY & RECOMMENDATIONS:

Figure 7

Case 7:07-cv-10711-KMK Document 1-11 Filed 11/30/2007 Page 9 of 25

TIME OF CONCENTRATION OF SMALL DRAINAGE BASINS



Note: 1) Use nomograph Tc for natural basins with well defined channels, for overland flow on bare earth, and for mowed grass roadside channels.

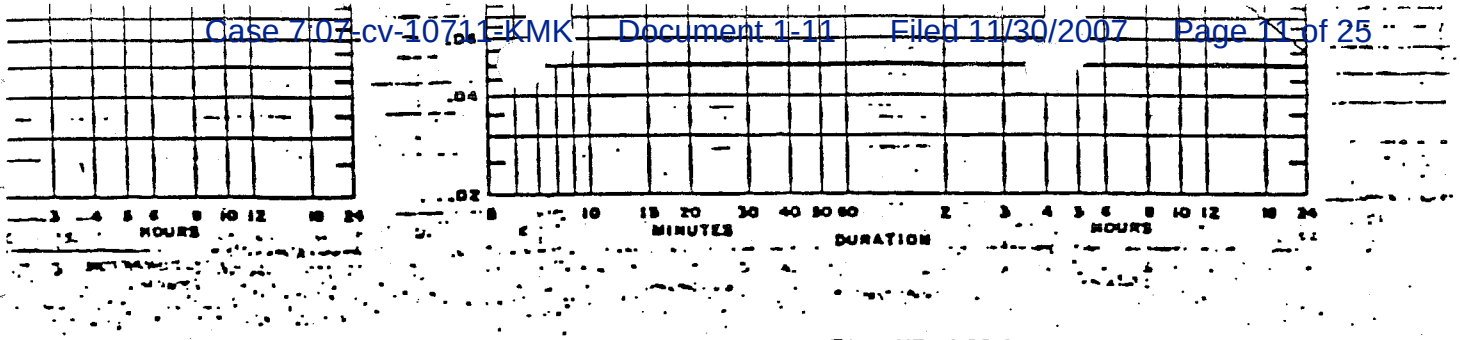
2) For overland flow, grassed surfaces, multiply Tc by 2.

3) for overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

4) For concrete channels, multiply Tc by 0.2.

Reference: Based on study by P.Z.Kirpich, Civil Engineering, Vol. 10, No. 6. June 1940. p. 362.

9/13



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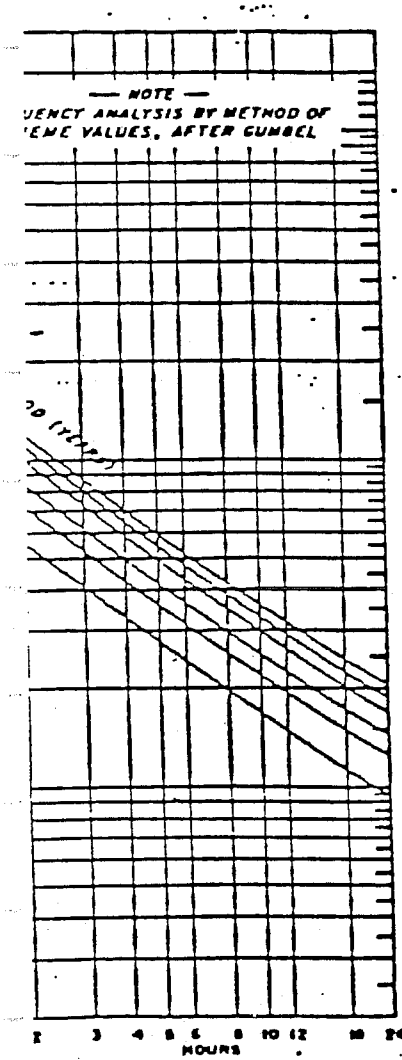
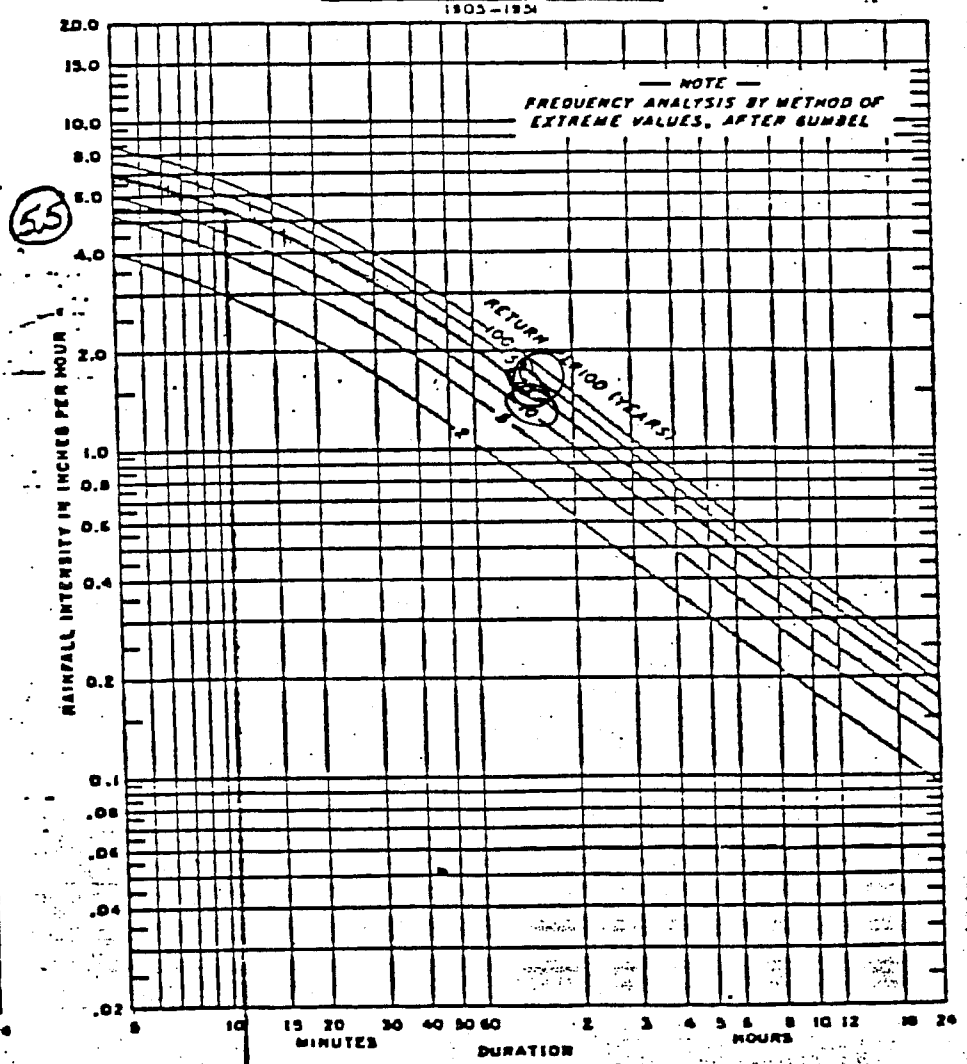
BINGHAMTON, NEW YORK
1903–1954





55

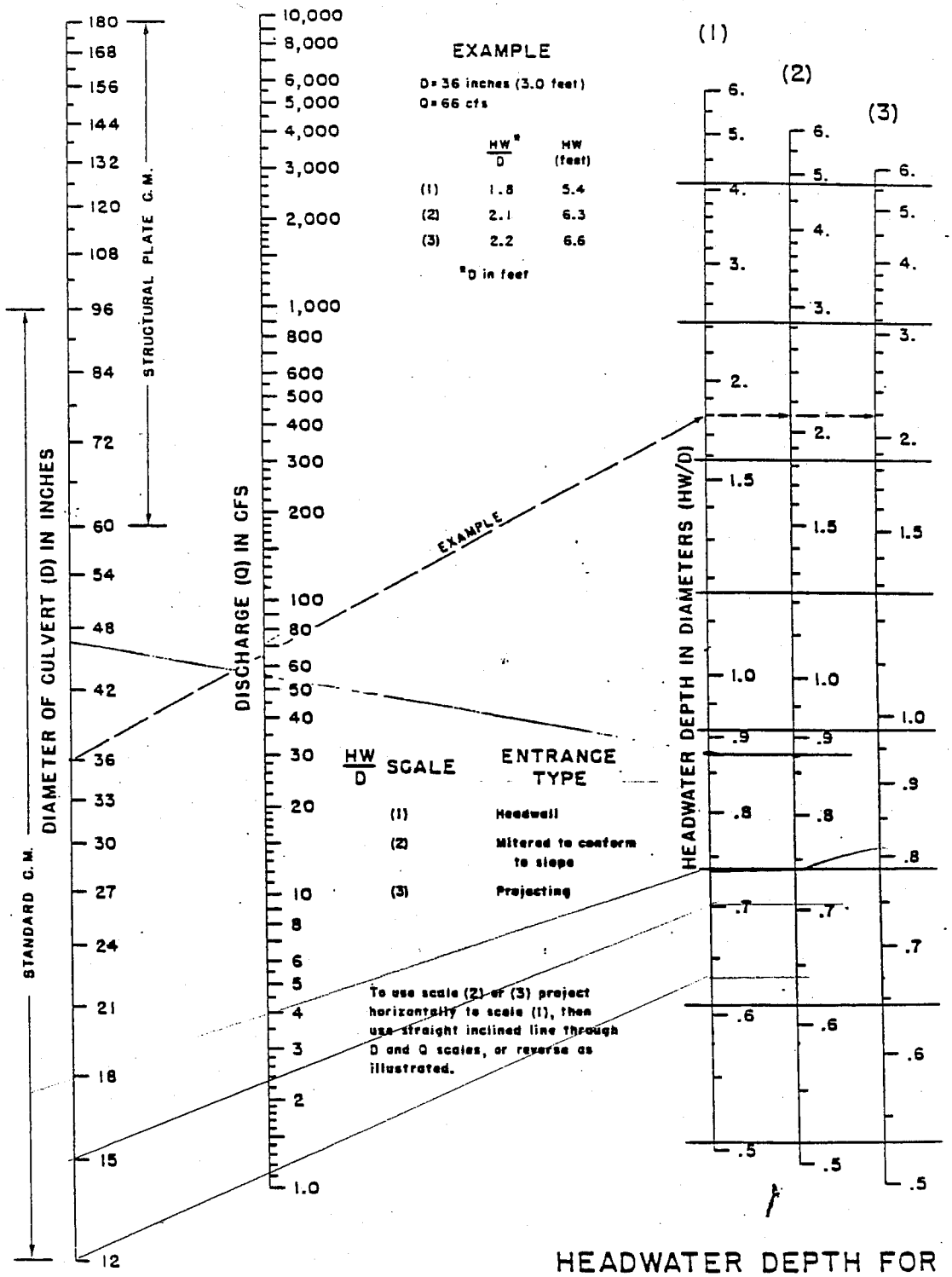
~ 11.3

25YR STORM

30

CHART 5

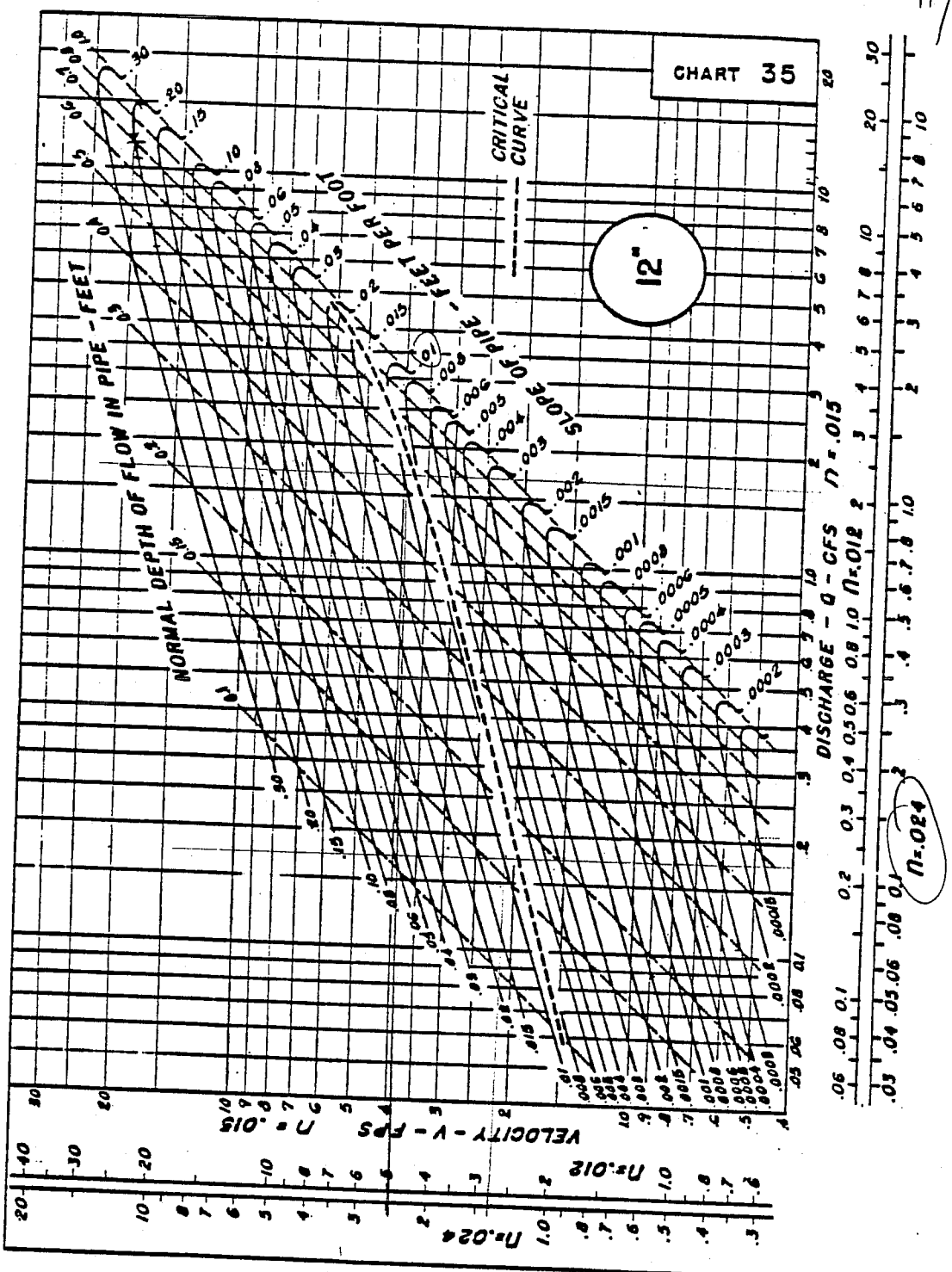
10/13



HEADWATER DEPTH FOR C. M. PIPE CULVERTS WITH INLET CONTROL

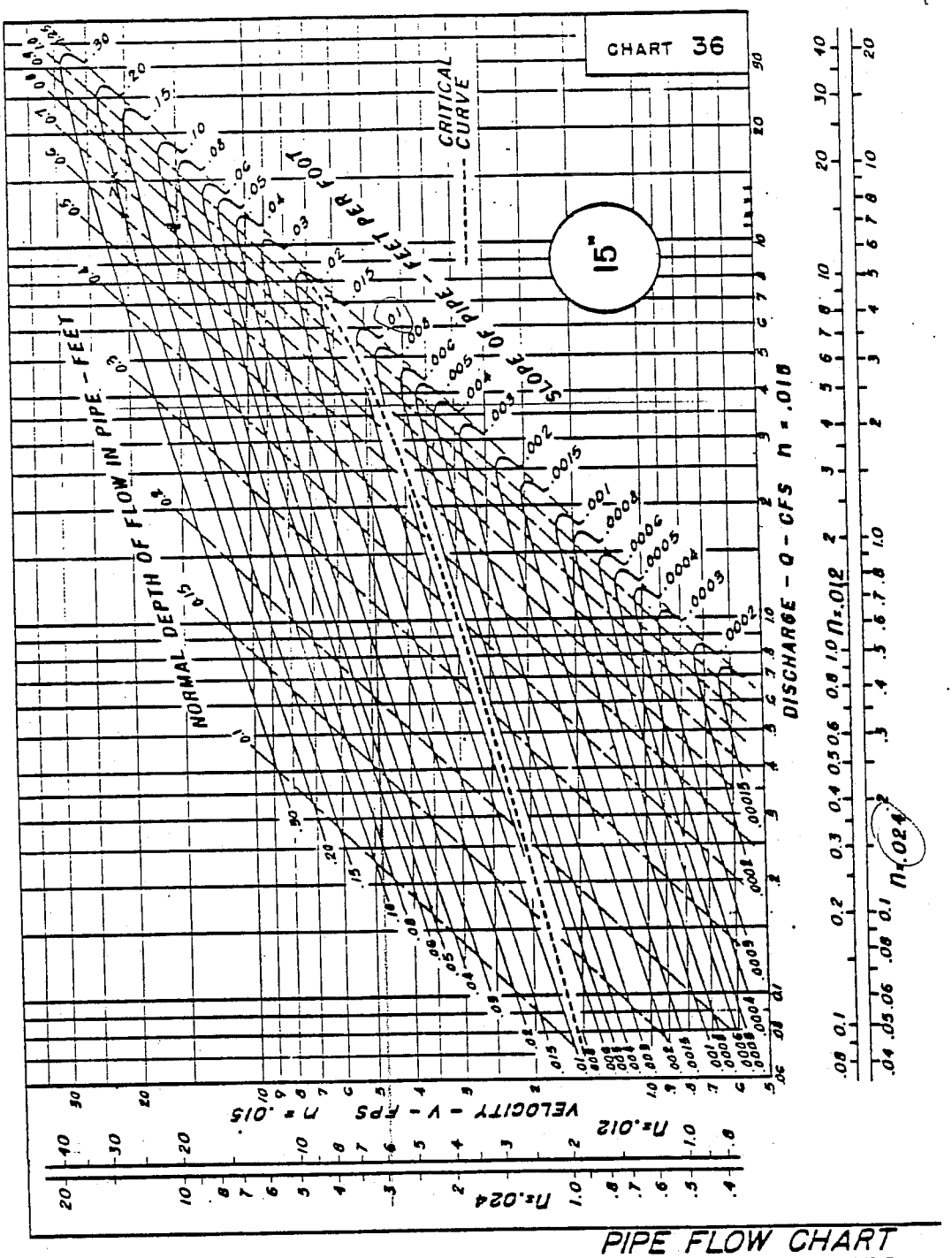
BUREAU OF PUBLIC ROADS JAN. 1963

11/13



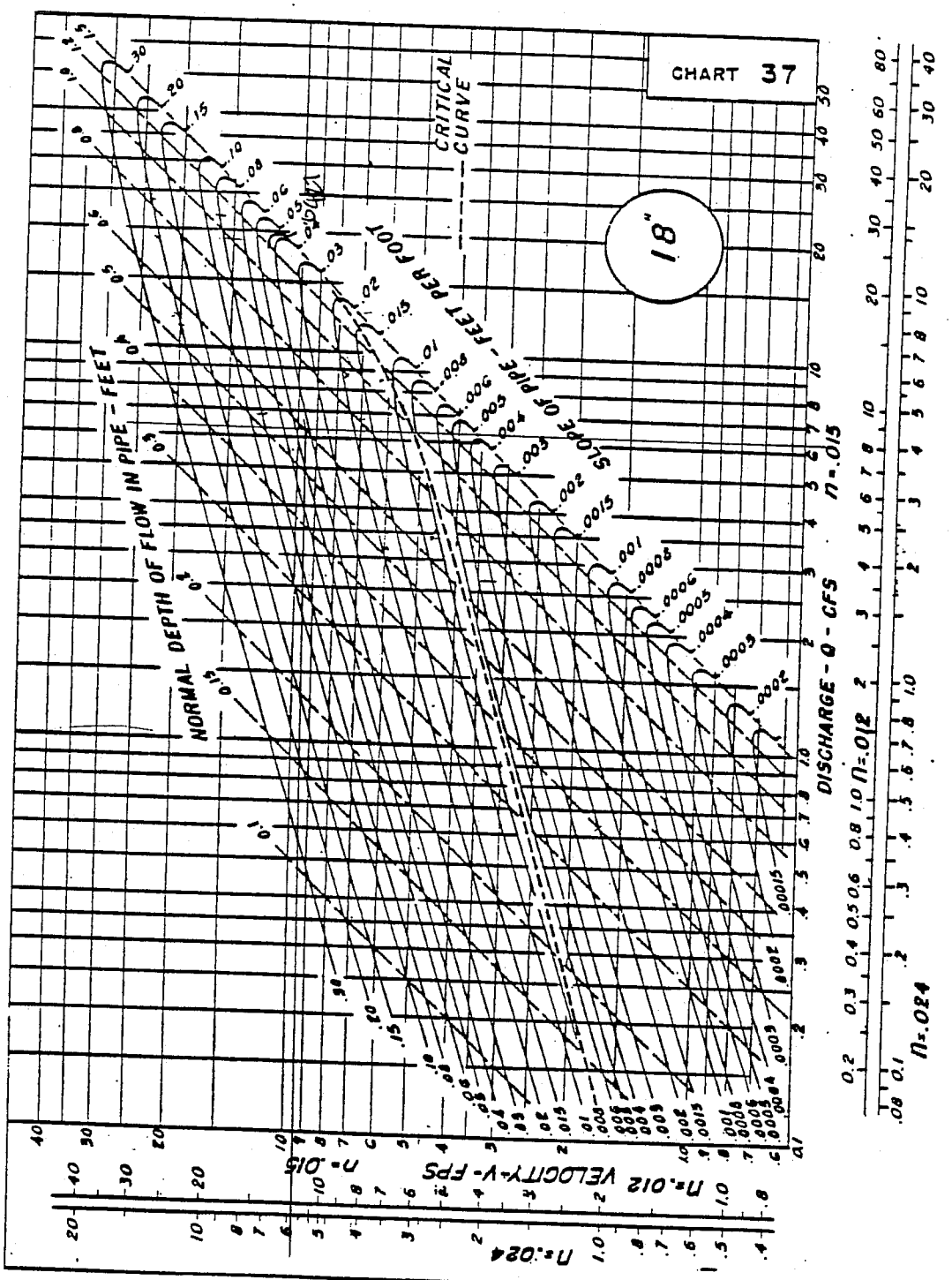
PIPE FLOW CHART
12-INCH DIAMETER

12/13



PIPE FLOW CHART
15-INCH DIAMETER

13/13



PIPE FLOW CHART
18-INCH DIAMETER

APPENDIX 3
EROSION AND SEDIMENT CONTROL DESIGN

By MJ Date 4/26/88 WEHRAN ENGINEERING Job No. 25534
Chkd. by [illegible] Date 12/88 Engineers & Scientists Sheet No. 1 of 9
Subject AREA CALCULATIONS

SCALE 1" = 100' SF/SI = 10,000

	PHASE	SI	AVE SI	SF	AC
FROM 100 SCALE	I	44.3 44.66	44.48	444800	10.2
	II	10.06 9.85 10.03	9.98	99,800	2.3
	III	7.7 7.6	7.65	76,500	1.8
	IV	7.9 7.94	7.92	79,200	1.8
	V	45.55 45.57	45.56	455,600	10.4
	ALL	79.32 79.08 79.11	79.17	791,700	18.2

100 SCALE PHOTOCOPY

OFF-SITE DRAINAGE	SI	AVE	SF	AC
PH I	2.47 2.52 2.50	2.5	25000	.57
PH II	3.67 3.69 3.64	3.67	36700	.84

200 SCALE

	SI	AVE	SF	AC
AREA W/ CHARGED FLOW PATTERN	[illegible] 3.01 2.9 2.96 2.96	2.96	118400	2.72

By ____ Date ____ WEHRAN ENGINEERING Job No. 0553-4
Chkd. by VJV Dat 7/18 Engineers & Scientists Sheet No. 2 of 9
Subject EROSION + SEDIMENT CONTROL

A. PURPOSE TO SIZE STRUCTURES TO DIVERT STORM WATER AWAY FROM ACTIVE MINE AREAS

PARAMETERS:
- SHALEY SILT LOAM SOIL
- AGRICULTURAL LAND
- SEED: TEMPORARY MIX
- DIVERSION WILL BE MAINTAINED
- DISCHARGE TO STABLE, VEGETATED AREA

- DESIGN STORM = 25 YR } PS 4.2.2
- REQ'D FREEBOARD = 0.3' }
- VELOCITY MAY 2.0 fps @ RET DTE
- C factor = .30 WOODED CN / ROCK/CROPS steep meadow

B. DIVERSION ABOVE PHASE I

$Q = CIA$

A = .57 AC
C = WOODED = .30
I: L = 170' H = 790 − 770 = 20' $T_c = 1 \times 2 = 2$

I = 7.0

$Q = (.3)(7)(.57) = 1.2$ cfs ≤ 5 cfs

USE SMALL DIVERSION SPECS 4.2.2

C. DIVERSION ABOVE PH. II

$Q = CIA$

A = .84
C = WOODED = .30
I: L = 300' H = 830 − 805 = 25 $T_c = 1.6 \times 2 = 3.2$

I = 7

$Q = (.3)(7)(.84) = 1.76$ cfs ≤ 5 USE SMALL DIVERSION SPECS

By [illegible] Date 4/88 WEHRAN ENGINEERING Job No. 87534
Chkd. by JW Date 4/88 Engineers & Scientists Sheet No. 3 of 9
Subject

D. DIVERSION ABOVE PH III

$Q = C I A$

$A = 2.3$
$C = .5$
I: $L = 180'$ $H = 805 - 760 = 45'$ $T_C = 1.0 \times 2 = 2$
$I = 7$

$Q = (.3)(7)(2.3) = 4.8$ c/s ≤ 5 c/s USE SMALL DIVERSION SPECS

E. DIVERSION ABOVE III

$Q = C I A$

$A = 1.8$
$C = .3$
$I =$ MINIMUM $= 7$

$Q = (.3)(7)(1.8) = 3.8 \leq 5$ c/s USE SMALL DIVERSION SPECS

F. DIVERSION ABOVE IV

$Q = C I A$

$A = 1.8$
$C = .3$
$I = 7$

$Q = (.3)(7)(1.8) = 3.8 \leq 5$ c/s

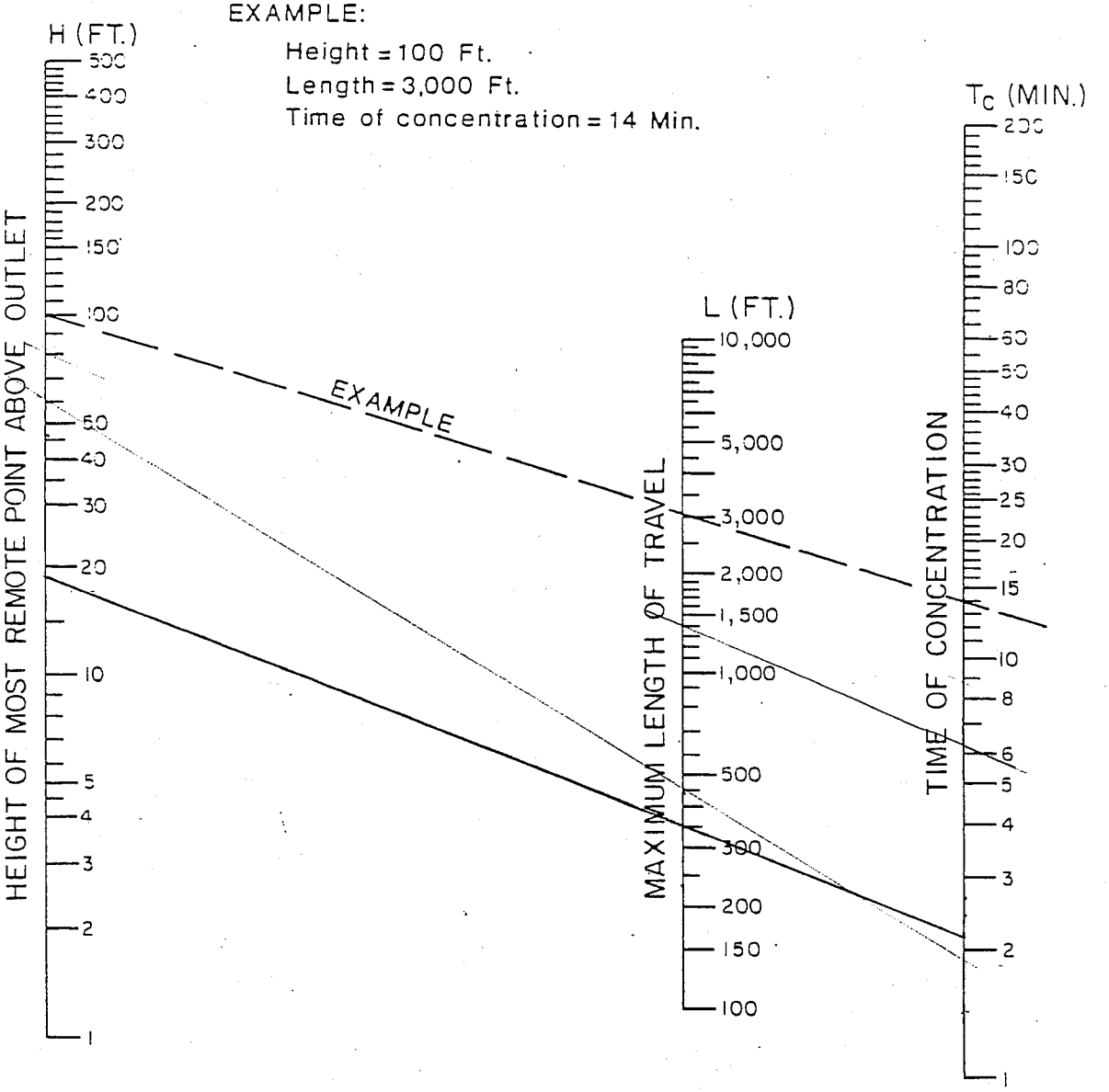
E. STONE OUTLET DIMENSIONS

$L = 6 \times$ CONTRIBUTING ACRES

MAX CONT. AREA = 2.3 AC $L = 6 \times 2.3 = 13.8'$
USE 14'

TIME OF CONCENTRATION OF SMALL DRAINAG BASINS

4/9



Note: 1) Use nomograph Tc for natural basins with well defined channels, for overland flow on bare earth, and for mowed grass roadside channels.

2) For overland flow, grassed surfaces, multiply Tc by 2.

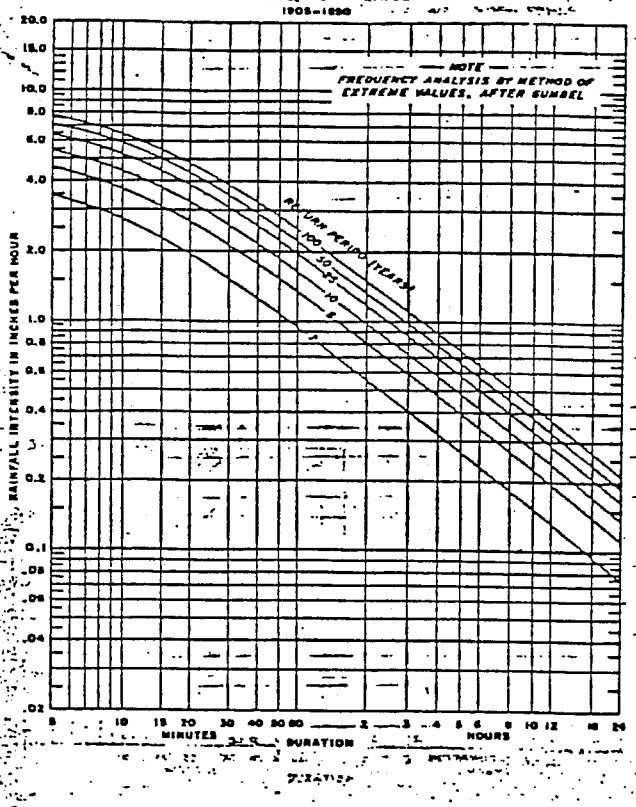
3) for overland flow, concrete or asphalt surfaces, multiply Tc by 0.4.

4) For concrete channels, multiply Tc by 0.2.

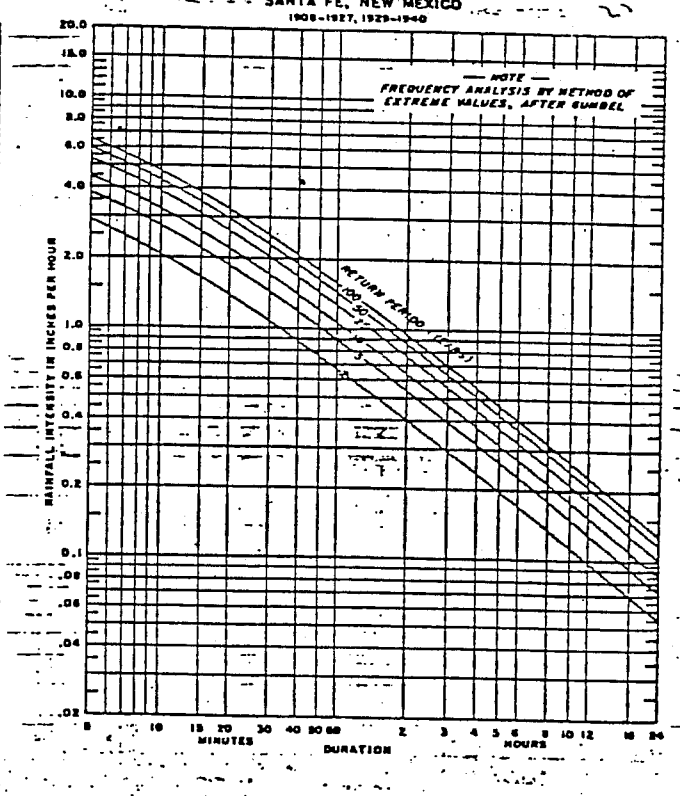
Reference: Based on study by P.Z.Kirpich, Civil Engineering, Vol. 10, No. 6. June 1940. p. 362.

RAINFALL INTENSITY–DURATION–FREQUENCY CURVES

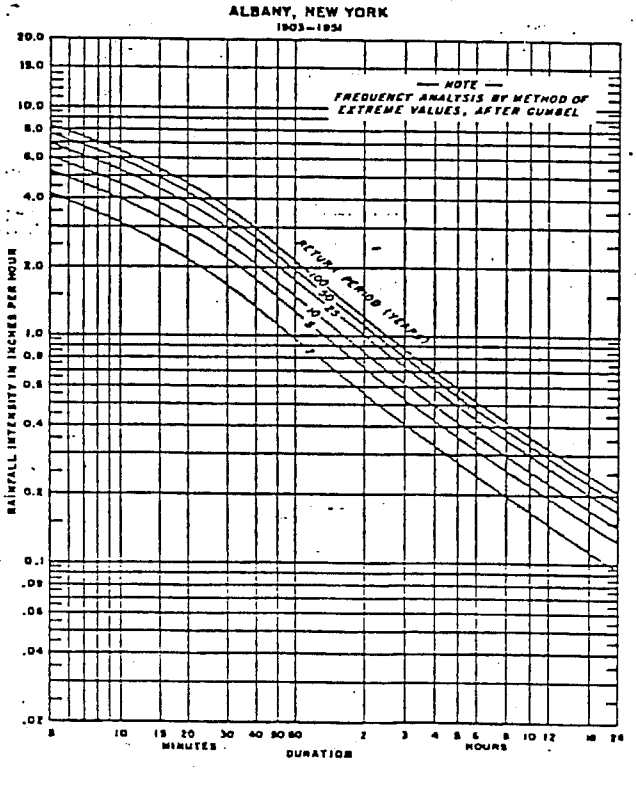
ROSWELL, NEW MEXICO
1905–1950



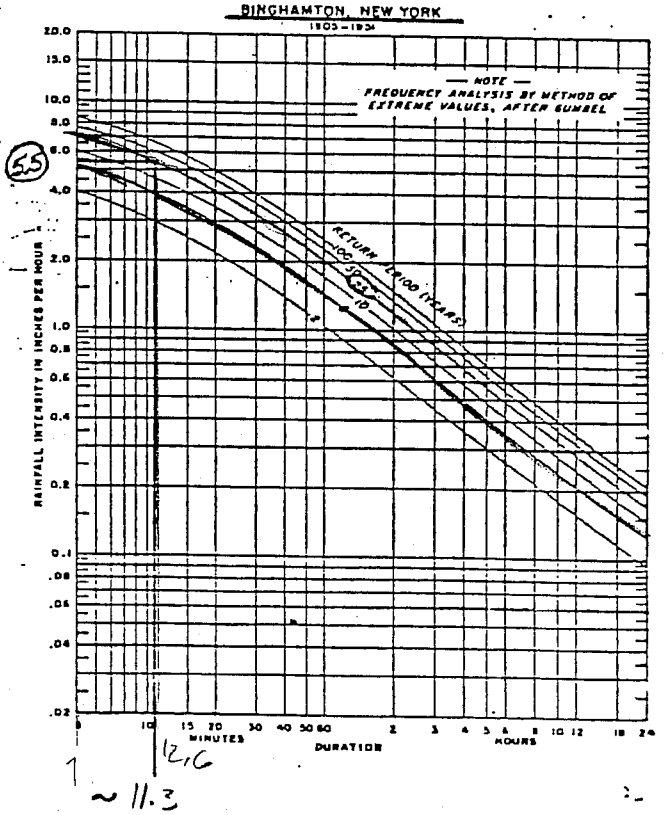
SANTA FE, NEW MEXICO
1908–1927, 1929–1940



ALBANY, NEW YORK
1903–1934



BINGHAMTON, NEW YORK
1905–1934



DT N TY	TYPICAL AREA OF PROTECTION	DESIGN STO FREQUENCY	FREEBOARD REQUIRED
Permanent	Agricultural Land	25 years	0.3 ft.
	Urban Land Areas, Play Fields, Recreation Areas, Agricultural Buildings, etc.	25 years	0.3 ft.
	Homes, schools, industrial buildings, etc.	50 years	0.5 ft.

Small Diversions

1. Where the diversion channel grade is between 0.25% and 5%, a permanent vegetative cover is planned and the design flow is equal to or less than given below, the dimensions given below for a parabolic channel may be used instead of preparing an individual design for the diversion.

	CHANNEL DIMENSIONS	
Q (cfs)	TOP WIDTH (ft.)	DEPTH (ft.)
5	12	1.9
10	22	1.9

The depth given above includes 0.3 ft. freeboard and 0.1 ft. settlement. Side slopes shall be 3:1 or flatter, and the ridge top width shall be 4 ft. or wider.

2. Where the diversion will be a temporary diversion to direct water off a graded right of way onto stable areas and the only area draining toward the diversion is the right of way; the following spacings, and the size given above for 5 cfs may be used instead of preparing individual designs for each diversion.

ROAD GRADE (percent)	APPROXIMATE DISTANCE BETWEEN DIVERSIONS (ft.)
1	400
2	245
5	125
10	78
15	58
20	47
25	40
30	35

Velocity

The maximum permissible velocity for design flow will be determined by the most erodible soil texture exposed and the type of vegetation expected and maintained in the channel. The following table will be used in selecting maximum permissible velocities:

Protection Against Sedimentation

When the movement of sediment into the diversion channel is a significant problem:

1. Land treatment or structural measures shall be installed to stabilize the source of sediment or trap the sediment.

2. If it is not possible to stabilize or trap the sediment, a filter strip of close growing grass shall be maintained above the diversion channel. The filter strip width measured from the center of the channel shall be at least one-half the channel top width plus 15 feet.

Outlet

Each diversion must have an adequate, stable outlet. The outlet may be: a grassed, stone centered, or lined waterway; a vegetated or paved area; a grade stabilization structure; a storm sewer; a stable watercourse; a tile outlet; or open channel.

The outlet, in all cases, must be stable and convey water to a disposal point where damage will not result. Constructed vegetative outlets must be established prior to diversion construction.

Temporary Stone Outlet Structure

A temporary stone outlet structure for a diversion may be used only where the contributing watershed is less than five acres. The minimum length, in feet, of the crest of the stone outlet ~~structure shall be equal to six times the number of acres of the contributing drainage area~~. The crest of the stone outlet structure shall be level and at least six inches lower than the lowest elevation of the top of the diversion. The stone shall be crushed stone and be 4" to 8" in diameter except for a one-foot thick blanket of 2" diameter stone on the upstream face.

The temporary stone outlet structure shall be located so as to discharge onto an already stabilized area or into a stable watercourse. The stone structure shall be embedded into the soil a minimum of four inches.

Permanent Cover and Erosion Protection

A permanent vegetative cover shall be established on all diversions in accordance with the Standards for Permanent Vegetative Cover for Soil Stabilization, p. 3.2.1 or Standards for Permanent Stabilization with Sod, p. 3.4.1. Where the season and other conditions may not be suitable for growing permanent erosion resistant cover, erosion protection will be provided in accordance with the Standards for Temporary Vegetative Cover for Soil Stabilization, p. 3.1.1 or Standards for Stabilization with Mulch Only, p. 3.3.1.

Diversions that are not designed to have a permanent vegetative cover shall be designed for bare channel velocities and with flat side slopes to prevent channel and side slope erosion. Diversions that are designed to have a permanent vegetative cover shall be seeded from the toe of the backslope to the upstream side of the designed channel width plus any required filter strip. Other areas disturbed by diversion construction shall also be seeded.

Installation Requirements

All trees, brush, stumps, or other objectionable material shall be removed so they will not interfere with construction or proper functioning of the diversion. All ditches or gullies which must be crossed will be filled and compacted prior to or as part of the construction. Fence rows and other obstructions that will interfere with construction or the successful operation of the diversion are to be removed.

Vegetation is to be removed and the base for the ridge thoroughly disked before placement of fill.

The minimum constructed cross-section is to meet the design requirements.

The top of the constructed ridge is not to be lower than the design elevation plus the specified amount for settlement.

Fertilizing, seeding, and mulching shall conform to the requirements in the Standards for Permanent Vegetative Cover for Soil Stabilization, p. 3.2.1.

If there is no sediment protection provided on temporary diversions, it should be anticipated that periodic cleanout may be required.

Construction operations shall be carried out in such a manner that erosion and air and water pollution will be minimized. State and local laws shall be complied with.

APPENDIX 4

BLASTING

By _____ Date _____ WEHRAN ENGINEERING Job No. _____
Chkd. by _____ Dat _____ Engineers & Scientists Sheet No. 1 of _____
Subject _____

A. BLASTING HAS BEEN OCCURRING ALTERNATE SATURDAY
BLASTING LOCATED ≈700' FROM EXISTING BLDGS.

B. DISTANCE TO EXISTING BUILDINGS/STRUCTURES FOR
PROPOSED BLASTING
KINGS RD ≈ 400'
POWERLINES ≈ 700'

C. PEAK PARTICLE VELOCITY LIMITS (MAX) FOR GROUND
VIBRATIONS WHEN DISTANCE FROM BLASTING SITE
= 301 - 5000' ⟹ 1.00 inch/sec

D. SCALE DISTANCE EQUATION WHEN DISTANCE
FROM BLASTING SITE = 301 - 5000'

$$W = \left(\frac{D}{55}\right)^2$$

W = max weight of explosives that can be detonated w/i 8 milliseconds

D = distance to site

$$W = \left(\frac{400}{55}\right)^2 = 53\#$$